XVII. *On Fossil Remains of Equines from Central and South America referable to* Equus conversidens, Ow., Equus tau, Ow., *and* Equus arcidens, Ow. *By Professor* Owen, *F.R.S. &c.*

Received November 17, 1868,—Read February 4, 1869.

Having examined the dental characters of existing species of the Horse-kind so far as seemed requisite for the determination of the Equine remains found in the Cavern of Bruniquel*, I have been enabled, on the same basis of comparison, to deal with other Equine fossils, and propose to communicate in the present Paper the results of this labour in elucidation of those which have reached me from some American localities.

In the account of the Mammalian Remains brought from South America in the 'Voyage of the Beagle,' I described and figured an upper molar tooth as belonging to a species of *Equus*†; and this tooth, having been found by Mr. Darwin imbedded in the quartz shingle of cemented pebbles at Punta Alta in Bahia Blanca, together with remains of *Megatherium*, *Megalonyx*, *Mylodon*, and *Scelidotherium*, I concluded not to be a tooth of a horse imported by Europeans into South America, but to have belonged to an Equine species which had coexisted with those large Megatherioids and had, with them, become extinct at a prehistoric period. An Equine upper molar tooth of similar pattern, included in the collection of fossils from the same 'Voyage,' was labelled as having been found in red argillaceous (postpliocene?) deposits at Santa Fé, in the province of Entre Rios, Buenos Ayres; and this tooth being associated in the series with parts of *Mastodon* and *Toxodon* confirmed me in the above conclusion‡.

In the Monograph of 1840, above quoted, I did not feel, however, that I had sufficient grounds for differentiating the species to which the two detached fossil teeth had belonged from *Equus caballus*, the upper molars of which seemed to differ from the fossils chiefly in a slight superiority of size, with some seemingly unimportant modifications of the complex but characteristically Equine enamel-folds.

But improved practice and attention to detail in the course of my work on 'Odontography' led me to appreciate the value of the latter indications, and to note a greater degree of curvature of the entire tooth, and also a greater relative antero-posterior diameter of the crown as compared with *Equus caballus*. I accordingly pointed out the distinctive character of these teeth as those of *Equus curvidens* in that work§; and I entered the specimens, Nos. 1030 & 1031, as of an *Equus curvidens* in my 'Catalogue

* *Ante*, pp. 535–557.

† The Zoology of the Voyage of H.M.S. 'Beagle,' pt. i. Fossil Mammalia, 4to, 1840, p. 108, pl. xxxii. fig. 13.

‡ *Tom. cit.* p. 109.

§ Odontography, p. 575 (1842).

of Fossil Organic Remains in the Museum of the Royal College of Surgeons,' vol. i. "Mammalia and Birds," 4to, 1845, p. 235.

It is unlikely—seeing the avidity with which the Indians of the Pampas have seized and subjugated the stray descendants of the European horses introduced by the Discoverers and 'Conquistadors' of South America, and the able use those nomad natives make of the multitudinous progeny of the Spanish war-horses at the present day—that any such tameable Equine should have been killed off or extirpated by the ancestors of the South-American aborigines. The circumstances of the discovery and the fact of the extinction in South America of a species of Horse would point to some other cause than that of the hostility of man to so useful an animal; and we might then in like manner give the benefit of such doubt as to extinction by human means to the contemporaries of the *Equus curvidens*, viz. *Megatherium*, *Toxodon*, *Macrauchenia*, *Glyptodon*, &c.

I am now able to adduce other evidences confirmatory of the distinctive characters of *Equus curvidens* from all known Equines, recent and fossil, of the Old World of geographers, and at the same time to extend the geographical distribution, in the New World, of this or a nearly allied species to Brazil and to Central America, in a direction toward the locality where Leidy has indicated its remains*.

With regard to fossil evidences of the Horse-kind in Brazil, we are mainly indebted to the persevering researches of that excellent naturalist, Dr. P. W. Lund, who devoted the last few years of his life, spent on account of failing health in Brazil, to a most valuable and instructive investigation of the limestone caverns in the interior Highlands of that country. In a letter dated "Lagoa Santa, 4th October, 1841," Dr. Lund communicated to the Royal Academy of Sciences, Copenhagen, a continuation of his Account of the Limestone Caves in the Interior of the Highlands of Brazil, in which, among the contents of the Cave B, Lapa do Bahu, appears "No. 16, *Equus neogæus*," (IV.) vol. xi. (1845) p. 76†. No other notice of the Equine fossils or of the character of the extinct species appears in this communication. In a subsequent letter, dated "Lagoa Santa, 22nd November, 1844," Dr. Lund gave results of later researches in those caves, which were published with plates in (IV.) 1846, vol. xii. p. 59. In this letter the genus *Scelidotherium* is cited, and in the 'Summary of the fossils from cursory inspection' (p. 86) there appears "No. 17, *Equus* aff. *caballo*."

Of this he proceeds to say that "the greater part of the skeleton of a young indi-

* Dr. Leidy notices some fossil Equine teeth as showing characters of *Equus curvidens* which had been discovered in upper tertiary deposits in Kentucky, North America: see 'Proceedings of the Academy of Sciences of Philadelphia,' September 1847, p. 262. Dr. Burmeister refers to the same species some teeth from the "laguna Siasgo of the Rio Salado, Buenos Ayres," in the 'Anales del Museo Publico de Buenos Ayres,' 4to, 1867, p. 245, pl. xiii.

† The Roman numeral (IV.) indicates, in this Paper, the work entitled "Det Kongelige Danske Videnskabernes Selskabs Natur. og Mathematiske Afhandlinger." The previous communications by Dr. Lund on this subject to the Danish Academy were translated by the Rev. W. Bilton, M.A., and published under the title "View of the Fauna of Brazil, previous to the last Geological Revolution," in the 'Magazine of Natural History,' New Series, 1840, p. 1. Up to that date he appears not to have met with Equine remains in the Brazilian caves.

vidual was obtained from one of the caves, which proved to be identical with that previously found, in the Sumidouro cave, associated with human bones" (p. 89). And we are enabled to judge of an instructive character of this Equine by the figure of the grinding-surface of the fourth molar, right side, upper jaw ("Fjerde Kindtand i hoïre Oberkjæve," p. 93, (IV.) tab. xlix. fig. 2).

This figure, to which I have added the symbols of characteristic parts of the grinding-surface used in my preceding memoir, is reproduced in fig. 12, Plate LXII., for the purpose of comparison with the type specimen of *Equus curvidens*, fig. 2, Plate LXI.

Of the difference of LUND'S *Equus* aff. *caballo* from his *Equus neogæus* and *Equus principalis*, the figures of the grinding-surface of the molars given in his tab. xlix. figs. 1 & 3 (figs. 9 & 10, Plate LXII.) leave no doubt. These specimens, Dr. LUND says, were extracted "from very old breccia"*. Without entering into any descriptive detail or comparison of them (which, indeed, would have been barely if at all available in the absence of the requisite descriptions and figures of the teeth of known species of *Equus*), he remarks, that† "*Equus neogæus* is more remote in the formation of the teeth from the common form of Horse than KAUP'S *Hippotherium*; and since that animal already shows such essential deviations from the single-hoofed form in the structure of the feet, it is to be presumed that *Equus neogæus*, when it is better known, will present still more considerable deviations. This is even more the case with *Equus principalis*, which, to judge from its deviating form of tooth, may well have possessed extremities as different from those of the Horse, as those animals which we, with OWEN, have learned to recognize as *Macrauchenia*, or, in other words, may be the same animal."

Leaving, for a while, this question, I will merely now remark that, through Dr. LUND'S discoveries of at least one kind of horse remarkably distinct from any existing species, and, I may add, any known European fossil Equine, all reasonable doubt as to that form or family of perissodactyle Ungulate having coexisted with *Megatherium* &c. in pliocene or postpliocene time, in South America, was set at rest.

Passing to the *Equus* aff. *caballo*, LUND, its discoverer, in reference to the association of its remains with those of Man, speculates as to "whether it may have been used by the inhabitants in those remote times as a domestic animal. It may," he proceeds, "easily be supposed possible to solve this question by a simple examination of the remains of the animal; but it will in all cases require a comprehensive comparison of a large number of specimens, since one of the results of domestication is to enlarge the limits for the play of individual variation. Upon the small number of specimens I have had

* "Der ikkun forekomme i meget gamle Breccier," (IV.) tom. xii. p. 89.

† "Thi *Equus neogæus* fjerner sig i Dannelsen af Tænderne meget mere fra den almindelige Hesteform, end KAUP'S *Hippotherium*, og da dette Dyr allerede udviser saa væsentlige Afvigelser fra Eenhoverformen i Bygningen af Födderne, er det at formode, at *Equus neogæus*, naar den bliver bedre bekjendt, vil frembyde endnu betydeligere Afvigelser. Dette gjelder endnu mere om *Equus principalis*, der efter sin afvigende Tandform at slutte, meget vel kunde have besiddet Extremiteter saa forskjellige fra Hestens, som de, vi ved OWEN have lært at kjende for *Macrauchenia*, med andre Ord, være det samme Dyr."—*Op. cit.* p. 90.

occasion to examine, which do not amount to more than three, naturally no conclusion in this respect can be founded; yet I must not omit to remark that in one of these specimens is observed a pathological phenomenon, namely, a deformity in the structure of one of the molar teeth. All three specimens, notwithstanding they were partly young animals, considerably exceeded in size full-grown specimens of the race of horses introduced by the Portuguese."—*Op. cit.* pp. 89–91.

With respect to the malformation ('deformitet'), of the nature of which no account is given, I may refer to the case of a hollow tumour near the base of the crown, described and figured in my 'British Fossil Mammals,' pp. 388, 389, figs. 146, 147, as occurring in a permanent lower molar of an '*Equus fossilis*' from the blue clay at Cromer, an instance which, from the nature of the fossil and its association with the Proboscidia and other extinct mammals of that formation, exemplifies the liability to disease in the mammals of that (newer pliocene) period.

Returning to Dr. LUND'S illustrations of the Equine fossils from the Brazilian caves, I may first remark that the one (fig. 12, Plate LXII.) discovered in the Sumidouro cave, in which human remains were found, in the points in which it differs from the existing Horse (Plate LVII. fig. 1, *p* 4) in regard to the pattern of the grinding-surface, and in size and shape, corresponds with that tooth on which the species *Equus curvidens* had been previously founded. No evidence whatever of the contemporaneity of the equine with the human remains in the Brazilian cave is adduced. A comparison of fig. 2, Plate LXI. (*Equus curvidens*, Ow.) with fig. 12, Plate LXII. (*Equus* aff. *caballo*, Ld.*), fig. 9, Plate LXII. (*Equus neogæus*†), and fig. 10, ib. (*Equus principalis*, Ld.)‡ will suffice to show that only to the first of LUND'S species can the *Equus curvidens* be referred, if, indeed, specific identity can be safely predicated on so few grounds as are afforded by the remarks of the Danish explorer. Unfortunately, in no part of Dr. LUND'S descriptions is any mention made of the degree of curvature of the teeth. It is possible that they were not obtained from the breccia sufficiently entire to yield this character; otherwise it could hardly have escaped the notice of so acute an observer§.

I shall recur in the sequel to the characters of the teeth which are unequivocally distinct from those of *Equus curvidens*, Ow., and of *Equus* aff. *caballo*, Ld., and now

* (IV.) Tab. xlix. fig. 2. † Ib. fig. 3. ‡ Ib. fig. 1.

§ I have also to regret the want of notice of this character in the account of the teeth of Equines, alleged to be fossils, brought from South America (locality not stated) by Count DE CASTELNAU, and from Tariga in Bolivia by Mr. WEDDELL. Professor GERVAIS, who has described and figured these specimens, remarks, "Il nous paraît probable que cet *Equus macrognathus* [Mr. WEDDELL'S specimen], notre *Equus americanus* du Chili, *l'Equus curvidens* de Buenos Ayres, et *l'Equus neogæus* des cavernes du Brésil, sont des animaux d'une seule et même espèce" —p. 34, pl. vii. 'Expédition dans les parties centrales de l'Amérique du Sud, &c. (1843–1847) sous la direction du Comte FRANÇOIS de CASTELNAU,' Septième Partie, Zoologie (Anatomie par M. PAUL GERVAIS), 4to, 1855. This remark leads me to doubt whether the figures in the original Danish Memoir of LUND had been seen by Professor GERVAIS.

proceed to the evidence of extinct Equines, more nearly allied to these latter, from a locality in Central America.

I was favoured, through the intervention of R. T. C. Middleton, Esq., of the British Legation, Mexico, in the year 1866, by receiving from Don Antonio del Castillo, Engineer of Mines, resident in Mexico, a series of specimens, casts, and photographs of objects of Natural History, including some fossil remains discovered by the liberal donor in newer Tertiary or Quaternary deposits in the valley of Mexico.

In this series were evidence of at least two species of *Equus*, consisting of portions of jaws with teeth, and detached teeth, found fossil associated with remains of *Mastodon* and *Elephas* and of an extinct *Cervus*.

One of the Equine species (*Equus conversidens*, Ow., Plate LXI. fig. 1) so far corresponds in the size, curvature, and pattern of the grinding-surface of the upper molar teeth with *Equus curvidens*, Ow. (ib. fig. 2) as would have led me to refer it thereto. But the chief Mexican fossil yields a character incompatible with an indication of the arrangement of the teeth in *Equus curvidens*, and which I have not before met with in any kind of horse, viz. a curved convergence of the two series of upper grinders towards the fore part of the palate to a degree exceeding that in other Equines (compare fig. 1 with fig. 6, Plate LXI.); and this peculiarity, with the curvature of the molars themselves, suggests a most interesting and significant resemblance to characters of the upper molars in *Toxodon* and *Nesodon**.

I therefore regard this Mexican fossil as representing a species which I propose to call *Equus conversidens*†.

The specimen (Plate LXI. fig. 1) is a portion of the upper jaw with the right and left series of grinders, and a considerable part of the intervening bony palate. Each dental series includes, as in the rest of the Equine family, three molars and three premolars. The premolars exceed the true molars in size to a greater degree than in *Equus asinus* (Plate LVIII. fig. 1): the true molars, *m* 1, 2, 3, in *Equus conversidens*, e. g., equal *p* 4, *p* 3, and the posterior lobe of *p* 2, while in *E. asinus* they equal *p* 4, *p* 3, and two-thirds of *p* 2, in longitudinal extent of grinding-surface. The disproportion between this extent of the true molars and that of the premolars is still greater in *E. conversidens* as compared with *E. caballus* (Plate LVII. fig. 1).

The last molar, *m* 3, fig. 1, Plate LXI., is relatively smaller than in any old-world Equine. The first premolar, *p* 2, resembles in the minor production of the anterior lobe that tooth in *Equus asinus*, *Equus quagga*, and differs in this respect from *E. caballus*. The grinding-surface, however, retains, as in *Equus* aff. *caballo*, Ld., and in *E. curvidens*, the general conformity of character of enamel-folding so remarkable in all the modern and in the European postpliocene Equine species hitherto described.

As compared with *Equus caballus* (Plate LVII. fig. 1), the dividing ridge (Plate LXI.

* Compare Plate LXI. fig. 1 with pl. xv. fig. 3, Philosophical Transactions, 1853, and with pl. 1, 'Fossil Mammalia of the Beagle,' 4to, 1840.

† From *converto*, to turn towards; or *conversus*, turned towards, and *dens*, a tooth.

fig. 1, *p* 4, *n*) between the outer longitudinal channels (*f*, *f'*) is narrower, and is not itself grooved along its summit; the dentinal lobes, *c*, *d*, have less thickness or extent in tl e direction from the outer to the inner side of the tooth; the production, *o*, of the lobe *d* is narrower, and the corresponding production or appendage, *m*, of the lobe *c* is narrower or more compressed from the outer to the inner side of the grinder; it is consequently less prominent; but it is equally expanded both anteriorly and posteriorly to the connecting isthmus. The folding of the enamel of the islands *h* and *i* is about as much as in *Equus curvidens*, Plate LXI. fig. 2, and in *E. caballus*, Plate LVII. fig. 1. But the most distinctive character of the upper grinders of *Equus conversidens* is their disposition in the jaw, denoted by the *nomen triviale* of the extinct Mexican Horse; and to the character of the curvature of the molar series of alveoli may be inferentially added a concomitant modification of the shape of the upper jaw itself, involving that of the lower one.

The bony palate is less arched or concave from side to side in *Equus conversidens* than in any modern Equine.

Admeasurements of part of the upper jaw and teeth of *Equus conversidens*, Plate LXI.

	inches.	lines.
The length of the molar series in a straight line	5	8
„ premolars „	3	3
„ molars „	2	5
Interspace between right and left last molars (*m* 3)	4	0
„ „ first premolars (*p* 2)	2	4

Figure 3, Plate LXI. gives the grinding-surface of the third and fourth milk-teeth, right side, upper jaw, corresponding in size with the third and fourth premolars of *Equus conversidens*, and most probably from a young animal of that species.

From the teeth figured by RÜTIMEYER* as the deciduous molars of the *Equus fossilis* those of *Equus conversidens* differ in the greater degree of compression of the crown from without inwards, in the minor indication of the indent *j*, and simpler character of the fold *g* (marking off the postinternal lobule), in the less prominence and in the flattening of the ridge *n* (dividing the channels *f*, *f'*), and in the minor thickness and prominence of the lobule *m*.

From the milk-molars of *Equus caballus* (Plate LVII. fig. 3, *d* 3, *d* 4) they differ also in the greater fore-and-aft extent and flattening of the external longitudinal ridge, *n*, in the minor relative breadth from without inwards, in the greater proportion of the part of the crown behind the lobule *m*, and in the more generally plicated disposition of the enamel.

The proportions of the crown of the permanent upper molars of *Equus fossilis* (from Kent's Hole, 'British Fossil Mammals,' p. 383, fig. 143) are well brought out in comparison with the immature teeth of *Equus fossilis* figured by RÜTIMEYER (*loc. cit.*); it is

* Beiträge zur Kenntniss der Fossilen Pferde, 8vo, 1863, Taf. I. fig. 12.

probable that those of the deciduous molars of the *Equus fossilis* from Kent's-Hole cavern may have resembled in their proportions those of the extinct Mexican Colt or Filly, represented in Plate LXI. fig. 3. I append, in millimetres and their English equivalents, the

Dimensions of the grinding-surface of the upper molars of *Equus conversidens*.

		metre.		inch.	lines.
p 2.	Antero-posterior breadth* . . .	0·030	=	1	$2\frac{1}{2}$
	Transverse breadth*	0·025	=	1	0
p 3.	Antero-posterior breadth . . .	0·025	=	1	0
	Transverse breadth	0·025	=	1	0
m 1.	Antero-posterior breadth	0·022	=	0	$10\frac{1}{2}$
	Transverse breadth	0·021	=	0	10
m 3.	Antero-posterior breadth	0·019	=	0	9
	Transverse breadth	0·018	=	0	$8\frac{1}{2}$

Equus tau, Ow.—This species is indicated by a series of five grinders of the upper jaw, Plate LXI. fig. 4, and of three grinders of the lower jaw, ib. fig. 5. The upper grinders include the three true molars (*m* 1–3) and the two contiguous premolars (*p* 3, *p* 4). They are as much smaller than the corresponding teeth of *Equus conversidens* as are those of the *Asinus fossilis* from the Oreston Cavern (Hist. of British Fossil Mammals, p. 396, figs. 157, 158) compared with the teeth of *Equus plicidens* (*op. cit.* p. 392, figs. 152, 153) from the same cavern, and they indicate a species about the size of the common Ass.

As compared with any of the smaller existing kinds of Equines (Plates LVIII., LIX.), the antero-posterior diameter of the grinding-surface of the crown, especially in the premolars, is in excess; and in this character *Equus tau* also differs from *Equus conversidens*, as it does in the greater relative size, especially antero-posterior breadth, of the last molar, fig. 4, *m* 3: *E. tau* further differs in the greater flattening, from without inward, of the inner lobe, *m*, of most of the molars.

The lower molars of *Equus tau* (Plate LXI. fig. 5, *p* 2, 3, 4) conform to their homotypes above, in their character of narrowness from without inward; the postero-internal enamel-fold, *g*, describes more neatly or definitely than that in other Equines the figure of a short-stemmed capital letter T, which suggested the *nomen triviale* of the second extinct Mexican species.

The fossils representing both species were discovered by Don Antonio del Castillo in the posttertiary deposits, above mentioned, of the Valley of Mexico.

Equus arcidens, Ow.—I have already alluded to the interest with which one views the direction of the deviations of the extinct American Equines from the ordinary type in connexion with the curvature of the grinders, the length of the crown, and the anteriorly converging curve of their sockets, as exemplified in *Equus curvidens* and *E. con-*

* Across middle of crown.

versidens. I now proceed to the description of some fossil Equine upper molars which show a curvature exceeding as much that in *Equus curvidens* (Plate LXII. fig. 16) as do the teeth in that species as compared with the upper molars of the Horse or Ass. The teeth of *Equus arcidens* (Plate LXII. figs. 3 & 7) compete in this respect with those of the extinct South-American pachyderm for which the term *Toxodon* was devised to express that character; and it may be remarked that both *Toxodon* and *Nesodon* resemble *Equus* in the great length of the crown of the grinding-teeth before the development of any roots, if such occur at any age in *Toxodon*.

The following are the circumstances under which I became cognizant of the present remarkable extinct species of South-American Horse.

I received from Her Britannic Majesty's Minister at Monte Video a letter of the date of May 29th, 1867, referring to the discovery of some fossil mammalian remains and their transmission to the British Museum, in which the Hon. Mr. LETTSOM writes, "Since that case was packed I have received four more teeth from the spot where the remains in Boxes 2 and 3 were met with, viz. the 'Arroyo Gutierrez.'"

This 'Arroyo' is a brook falling into the 'Arroyo Negro;' and the spot where the teeth and other fossils were found is ten leagues south of Paysandi, in the Republic of Monte Video.

The other fossils referred to are parts of a Megathere and Glyptodon. The 'four teeth' subsequently received by Mr. LETTSOM and transmitted to the British Museum (Plate LXII. figs. 1–8) present a character of the grinding-surface having a general conformity to that in the *Equus neogæus* (fig. 9) and *Equus principalis* (fig. 10) of LUND. Assuming those Brazilian cave-fossil teeth also to have participated with the present ones from the Megatherian deposits of Monte Video in the degree of curvature, they may well indicate a section of extinct Equines having affinities, in the direction hinted at by the acute Danish naturalist, to certain more singular extinct American forms of Ungulates. Both the present and the Brazilian species above cited differ in a marked and unmistakable degree, in the pattern of the grinding-surface of the upper molars (as doubtless also of the lower ones), from *Equus curvidens*, *Equus conversidens*, *Equus tau*, as well as from *Equus macrognathus* (WEDDELL) (Plate LXII. fig. 11) and *Equus Devillei** (GERVAIS), represented by figures (unfortunately of half the natural size) in

* Of *Equus Devillei*, Gerv. (*op. cit.* pl. vii. fig. 11), Professor GERVAIS appears not to have received any upper molars: he records that, whereas the lower molar series of *E. macrognathus* (*ib.* fig. 4) has a longitudinal extent of 0·195^{m} (=7″ 7‴), that of *E. Devillei* only gives 0·160^{m} (=6″ 4‴)—and that they have a rather different disposition of the internal enamel-fold (of the lower molars), which seems from the figure (copied in fig. 17, Plate LXII.) to be less deep and less expanded in the antero-posterior direction than in *E. macrognathus*. In this respect both species, and *à fortiori Equus Devillei*, differ from *E. tau*. With respect to the "*Eq. curvidens* de Buenos Ayres," cited by M. GERVAIS (*op. cit.* p. 34), I may remark that, as yet, I have not received any evidence of that extinct species of Horse from the Province of Buenos Ayres. The specimens on which the species was founded were obtained at Bajada de Santa Fé, in the Province of Entre Rios, and at Bahia Blanca, on the confines of Northern Patagonia. The species from Buenos Ayres so called by BURMEISTER (*op. cit.* 1867) has upper molars more resembling those of *Equus principalis*, Ld., and of *E. arcidens*, Ow.

pl. vii. of CASTELNAU'S 'Expédition dans les Parties centrales de l'Amérique du Sud,' &c., 4to, 1855. The four molars from the Arroyo Gutierrez (Plate LXII. figs. 1–8) show the same mineral characters and coloration as do the bones and teeth of the Glyptodon and Megatherioids from that locality, and beget a conviction of their being fossils of the same age.

The molars are from the right side of the upper jaw, and probably belonged to the same head. Two show attrition of the grinding-surface; and two, with the body of the tooth fully formed, had not cut the gum.

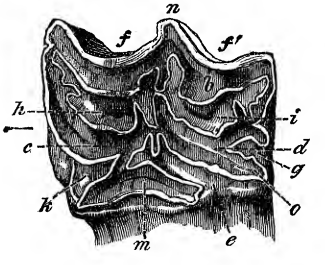
The larger of these unused grinders is probably *p* 4 (I made a section of this tooth, which is figured in Plate LXII. fig. 4); the smaller is *m* 3 (ib. fig. 8). The larger of the worn teeth may be *p* 3 (ib. figs. 1, 2, 3), the smaller one is *m* 2 (ib. figs. 5, 6, 7).

There is strong analogical probability that, in the present as in other species of Equines, the premolars exceeded the true molars in size (as, according to the above determinations, they do) in the degree shown in figures 1, 4, 5, 8.

The proportional smallness of the *m* 3 (ib. fig. 8) resembles that in the similarly unworn tooth of the Zebra (*ante*, Plate LX. fig. 1, *m* 3) and *Equus spelæus*, Ow. (ib. Plate LX. fig. 4, *m* 3). In all these the disparity is less marked when the tooth *m* 3 comes to be worn down to its thicker part; it would then, in *Equus arcidens*, exceed, in regard to relative size to the other teeth, the last molar in *Equus conversidens* (Plate LXI. fig. 1, *m* 3).

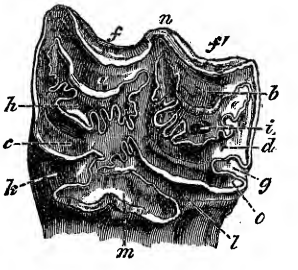
Comparing the tooth which I regard as *p* 4 (Plate LXII. fig. 4) with that in the *Equus fossilis* from the Oreston Cavern (Cut, fig. 1), and comparing *p* 3 of *E. arcidens* with *p* 3 of *Equus plicidens* (Cut, fig. 2), or comparing both teeth of *E. arcidens* with

Fig. 1.



Upper molar, *p* 4, *Equus fossilis*.

Fig. 2.



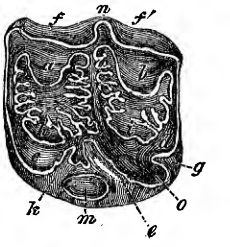
Upper molar, *p* 3, *Equus plicidens*.

their homologues in the Horse (*E. caballus*, Plate LVII., fig. 1, *p* 3, *p* 4), the antero-external groove *f* is deeper and more semicylindrical in *E. arcidens*; the dividing ridge, ib. *n*, is narrower, more produced, not pinched in at the base as sometimes in *E. caballus*, nor grooved along the summit (Plate LXII. fig. 1, *p* 3, *n*). The dentinal lobes in *E. arcidens* (Plate LXII. fig. 1, *a*, *b*) are narrower transversely, or from the outer to the inner side of the tooth, than in the Horse, and, from the more equal and regular curve of the inner enamel-wall of the lobes, which is nearly parallel with the outer one, these lobes are more definitely crescentic: the Ass's (Plate LVIII. fig. 1) and Zebra's molars (Plate LX.

fig. 1) rather more resemble, than do the Horse's (Plate LVII. fig. 1), the present fossils in this character. The islands of dentine and cement (Plate LXII. figs. 1, 4, *h*, *i*) in the worn teeth are relatively larger to the rest of the grinding-surface in *Equus arcidens*. They are bounded toward the inner side of the tooth by a ridge of enamel more equably curved and more parallel with the outer ridge than in the common Horse or other old-world species of *Equus*: this ridge, however, is occasionally subject to secondary plications, as shown in the section of the premolar, fig. 4, Plate LXII.

The lobes *c*, *d*, in *E. arcidens* (Plate LXII. figs. 4, 5) are relatively narrower and more regularly crescentic. The lobe *c* sends off the peninsula of enamel *m*, which with the enclosed dentine is, in proportion to the crown of the tooth, much smaller and more simple than in all other known Equines, recent or extinct, excepting the Brazilian *E. neogæus* and *E. principalis*, Ld. (figs. 9 & 10); it is not, however, an insular summit of a distinct column of enamelled dentine as in the Miocene Hipparions (*Hippotherium*, Kaup) (Cut, fig. 3, *m*).

Fig. 3.



Upper molar, *Hipparion*.

In both the worn molars of *Equus arcidens* the peninsular lobule *m* first extends inward and then curves backward, the enamel-wall very slightly expanding in the backward curve. The end of the entering peninsula of cement, *e*, is more expanded as the projecting peninsula, *m*, is more contracted: in *m* 2, fig. 5, it is not encroached upon by any enamel-fold from the lobe *c*; but it is so in the teeth *p* 3 and 4. The fore part of the peninsula *m* extends forward more or less in all other newer tertiary Equines, save *E. neogæus* and *E. principalis*, as it does in all existing species (as at *p*, Plates LVII.–LX.); but less so in the Ass- and Zebra-groups, in which the process *m* is relatively smaller than in the Horse. Thus the more simple shape as well as smaller size of the process *m* in Plate LXII. figs. 1, 4, 5, 9, 10, is amongst the well-marked characteristics of the upper molars of the group represented by *Equus arcidens*, *E. neogæus*, and *E. principalis*.

The entering fold, *g*, figs. 1, 4, 5, Plate LXII., which marks off an appendage of the lobe *d*, is relatively deeper in *Equus arcidens* than in *E. caballus*; and the process, *o*, of *d* is more distinct and more like a posterior serial repetition of the process *m* in *E. arcidens*.

The lines of enamel, generally, on the grinding-surface of the upper molars of *Equus arcidens*, are less interrupted by folds and waves than in most *Equidæ*, showing in this respect the opposite extreme to those in the extinct *Equus plicidens*, Ow.*, of European postpliocene beds. But the most conspicuous and readily appreciable character of the present teeth from the postpliocene (?) beds of Paysandi is the greater degree of longitudinal curvature of the entire tooth (Plate LXII. figs. 3, 7), the molars retaining the generic Equine character in the length of the crown before it becomes divided into roots.

* History of British Fossil Mammals, 8vo, 1846, p. 393, fig. 153.

Owing to the non-production of the fore part of the lobe *m* (figs. 1, 4 & 5, Plate LXII.) the groove *r* (ib. ib.) is less marked, and appears on the inner concave surface (fig. 2) rather than on the fore and flattened surface of the tooth as in *E. caballus* and *E. curvidens* (fig. 16).

The longitudinal groove, *e*, on the concave inner surface (fig. 2), at the entry of the enamel-fold (fig. 1, *e*), is nearer the middle of that surface, as in *Equus principalis*, Ld., and is less near the posterior angle than in other Equines; and there is no groove answering to the middle of the inner surface of the process *m*, which process is there more or less indented in most other Equines. On the outer or convex surface (Plate LXII. fig. 6) the simplicity, narrowness, almost sharpness of the produced mid ridge, *h*, adds a differential character to the great longitudinal convexity of that surface in *Equus arcidens*. The posterior surface (fig. 3) is slightly concave from within outwards, shows a feeble indication of the entry of the fold *g*, and, owing to the minor production of the external angle, a greater proportion of the posterior longitudinal channel, *f*, is visible, looking at the back part of the tooth, than in other Equines.

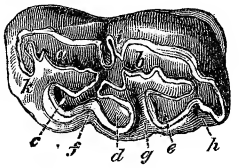
The upper molar tooth representing the *Equus neogæus* of Lund (*op. cit.*, IV. tab. xlix. fig. 3) indicates a species as much smaller than *Equus arcidens* as is the Ass than the Horse. It is determined by that acute and careful observer as being the fourth molar of the right upper jaw (Fjerde Kindtand i hoïre Overkjæve, *tom. cit.* p. 93); it answers very nearly to the true molar which, in *Equus arcidens*, is represented in fig. 5, Plate LXII. By reference to the copy of Lund's figure in fig. 9 of this Plate, it appears that the lobe *c* extends, in *E. neogæus*, nearer to the antinternal angle, and communicates, through attrition, with the dentine of lobe *d*: the posterior surface of the tooth is, likewise, relatively narrower, the lobule *o* smaller, and the entering fold *g* shallower. These differences, with that of size, and in the absence of any knowledge of the degree of general curvature of the entire molar, forbid a reference of *Equus arcidens* to *E. neogæus*.

The *Equus principalis*, Ld., is represented by an upper molar indicative of a horse of equal size with *Equus arcidens*. The fossil molar tooth from the older breccia of the Brazilian cavern, figured in tab. xlix. fig. i. *tom. cit.* (copied in fig. 10, Plate LXII.), is determined by Lund to be the fifth molar of the right upper jaw, $=m\,2$ ("Femte Kindtand i hoïre Overkjæve," p. 93). It cannot be either the first, $p\,2$, or the last, $m\,3$, of the series; yet it differs more from the ordinary shape of the grinding-surface of the Equine molars, well preserved in *E. arcidens*, than do either of those modified molars at the two extremes of the series. The molar representing Lund's *Equus principalis* offers an interesting and suggestive resemblance to the upper molars of *Palæotherium* and to some teeth of species of *Rhinoceros*, in the contraction of the crown toward the inner surface, whereby the ordinary subquadrate form of the section of the upper Equine molar (as shown in all the figures illustrative of the present and preceding Papers) is exchanged for a subtriangular form, with the inner angle obtusely rounded off. Nevertheless all the characters indicated by letters in the figures above-cited, especially fig. 9, are present in *E. principalis*, Ld. The terminal lobules, *m*, *o*, of the lobes *c*, *d* are equal

and parallel in position, as in *Palæotherium*; the fold *g*, as in *E. neogæus*, is less deep than in *E. arcidens*; the posterior ridge bounding the posterior outer longitudinal channel, *f'*, is not developed in *E. principalis* (at least in the representative molar of that species). The more important differences above defined are so well marked in this tooth as to lead to the inference that they would more or less characterize the whole upper molar series. Whether, or in what degree, the entire tooth was curved is not known.

I regret that I have no specimen of the lower molars of *Equus arcidens*. Dr. Lund figures the grinding-surface of the second true molar, left side, under jaw, of his *E. neogæus* (*tom. cit.*, IV. tab. xlix. fig. 5, copied in fig. 14, Plate LXII.), which shows as marked and interesting a departure from the pattern of the grinding-surface of these teeth in other Equines as does the upper molar. The external mid cleft (*i*) is deep and simple; and the outer surface of the two divisions of the molar (*a*, *b*) are regularly convex and to a degree corresponding with the concavities of the same part in the answering divisions of the upper molars, as shown in Plate LXII. fig. 9, at *f*, *f'*. The entering folds (fig. 14, *k*, *g*) at the inner side of the lower molar simply curve backward, do not expand terminally, and are wider at their beginning than in other Equines. There is barely a trace of the mid internal indent, *f*, fig. 4, of the *Equus fossilis*, from the Oreston Cavern (Cut, fig. 4), and in the figures of the Equine lower molars illustrative of the present Paper and its predecessor, and as in *E.* aff. *caballo* (=*E. curvidens*?, Plate LXII. fig. 15). Thus we have, in *E. neogæus*, as we most probably should have in *E. principalis* and *E. arcidens*, lower molars retaining more of the type of such teeth in *Palæotherium* and *Rhinoceros* than they do in ordinary recent and fossil Equines.

Fig. 4.



Lower molar, *p* 4, *Equus fossilis*.

In my 'Odontography' I described and figured the molar series of the left ramus of a lower jaw, found fossil in the Pampas Deposits at Buenos Ayres, as being of a *Macrauchenia*, from the indications of the affinity of that genus to the perissodactyle section of Cuvier's Pachyderms which had been detailed in the first account of that singular genus*. The subsequent discoveries of M. Bravard of parts of *Macrauchenia*, including the entire skull and dentition, confirmed the accuracy of that determination of the lower molars and of the generic distinction of the extinct animal.

* "In the ungulate series there are but two known genera (the *Rhinoceros* and *Palæotherium*) which, like the quadruped in question, have only three toes on the fore foot. Again, in referring the *Macrauchenia* to the tridactyle family of Pachyderms, we find towards the close of our analysis, and by a detailed comparison of individual bones, that the *Macrauchenia* has the closest affinity to the *Palæotherium*. But the *Palæotherium*, like the *Rhinoceros* and *Tapir*, has the ulna distinct from the radius, and the fibula from the tibia; so that even if the Parisian Pachyderm had actually presented the same peculiarities of the cervical vertebræ as the Patagonian one, it would have been hazardous, to say the least, while ignorant of the dentition of the latter, to refer it to the genus *Palæotherium*. Most interesting, indeed, will be the knowledge, whenever the means of obtaining it may arrive, of the structure of the skull and teeth in the *Macrauchenia*."—*The Zoology of the Voyage of H.M.S.* '*Beagle*,' Part I., Fossil Mammalia, 4to, 1840, p. 54, pls. vi.–xv.

I have given, in Plate LXII. fig. 13, a view of the grinding-surface of the second true molar of the *Macrauchenia* in the British Museum, of the natural size ; the reduced figure in the 'Odontography' may have suggested to Dr. LUND the idea of its being the same animal as his *Equus principalis* (see above, p. 561). The degree of resemblance is, however, not greater than both figs. 13 & 14, Plate LXII. offer to the corresponding teeth of *Palæotherium** and *Paloplotherium*†, at a similar degree of abrasion.

In the upper molars of *Macrauchenia* we find an interesting transitional modification between the generic pattern of the grinding-surface of the American extinct Equines (*E. neogæus*, *E. principalis*, *E. arcidens*) and that in *Nesodon*. The outer surface of the crown is impressed by two wide and moderately deep longitudinal channels, more angular as in *Palæotherium* than rounded as in *Equus*; a pair of depressions, answering to those marked *h* and *i* in *Equus*, appear to be shallower, are sooner blended together and obliterated. Three enamel-folds penetrate the inner side of the tooth, answering to those marked *r*, *e*, *g* in *Equus*, the middle one, *e*, also extending the furthest; but all these are shallower, save at their blind terminations, which consequently remain in the partially abraded crown as distinct islands of enamel including cement, and thus produce a characteristic resemblance to the dental pattern in *Nesodon*. The upper molars of *Nesodon*‡ differ from those of *Macrauchenia* in the crown being longer and transversely narrower; the outer longitudinal ridge is near the anterior border, not at the middle of that border; the inner border is penetrated by two enamel-folds, of which the anterior is bifurcate or three-branched; and the extremities of the folds, when insulated by wear, are nearer the outer border of the tooth.

The lower molars of *Nesodon*§ differ from those of *Macrauchenia* in the crowns being longer and transversely narrower; the outer longitudinal groove is nearer the anterior border; the anterior inner fold penetrates a plane behind the outer groove, advancing obliquely forward to meet it. Besides the posterior fold there is an island, which, if originally a part of that fold, is, in the worn tooth figured, separated from it. The canines are small and subequal to the other teeth in both genera, but are implanted by a divided fang in *Macrauchenia*. The lower incisors have an imbricate or slightly overlapping arrangement in *Nesodon*.

The upper molars of *Macrauchenia*, in the proportion of their fore-and-aft to their transverse diameters, are intermediate between *Equus* and *Nesodon*, but nearer the former. The high or backward position of the external nostrils in *Macrauchenia* is significant evidence of its affinity to *Toxodon*; and it may be that *Nesodon* shows more of this character than the fragment of skull on which the genus was founded led me to discern ‖.

Howsoever this may prove to be, the additional evidence which has been obtained

* Ossemens Fossiles, 4to, t. iii. pl. i. fig. 3.

† Quarterly Journal of Geological Society, vol. iv. pl. iv. fig. 3.

‡ Philosophical Transactions (1853), Pl. XVII. fig. 10.

§ Ibid. fig. 14.

‖ Philosophical Transactions (1853), Pl. XV. figs. 1 & 2.

relative to both *Toxodon* and *Macrauchenia* supports and further illustrates the views of their affinity indicated by the order in which their dentition is illustrated in my 'Odontography'*.

In the present Paper I am enabled to adduce facts showing that the most ancient known indigenous Equines of the South-American continent presented modifications of the upper molars, and more especially of the lower molars, which supply an additional link in the connexion of the singular group of Mammals formed by *Toxodon*, *Nesodon*, and *Macrauchenia* with the Equines and the rest of the Perissodactyle order of Ungulates.

Concurring with Dr. Lund in the surmise that the Equines in question may, like the Hipparion† or Hippotheres‡ of the Old World, show concomitant modifications of limb-structure, I would propose the term *Hippidion*§ for the group represented by the species *neogæus*, *principalis*, and *arcidens*.

Description of the Plates.

PLATE LXI.

Fig. 1. Palatal and alveolar portions of upper jaw, with right and left series of upper grinders *in situ*, of *Equus conversidens*.

Fig. 2. Grinding-surface of last premolar (type tooth) of *Equus curvidens* (from Owen's 'Fossil Mammalia of the Beagle,' 4to, plate xxxii. fig. 13).

Fig. 3. Grinding-surface of last two deciduous molars, *d* 3, *d* 4, of *Equus conversidens*.

Fig. 4. Series of grinders (less first, *p* 2) of left side, upper jaw, of *Equus tau*.

Fig. 5. First three grinders of lower jaw, *p* 2, *p* 3, *p* 4, left side, lower jaw, of *Equus tau*.

The above figures are of the natural size.

Fig. 6. Palatal surface and teeth of upper jaw of the common Horse (*Equus caballus*, Lin.), one-fourth the natural size.

PLATE LXII.

Equus (*Hippidion*) *arcidens*, Ow.

Fig. 1. Worn grinding-surface of an upper grinder, probably *p* 3.

Fig. 2. Inner concave side of the same tooth.

Fig. 3. Hinder surface of ditto.

* *Equus, Toxodon, Rhinoceros, Palæotherium, Macrauchenia.* The Horse and Toxodon were approximated on account of the length of the crowns of the grinders.—*Op. cit.* pp. 572–603.

† Christol, 'Annales Scient. et Industr. du Midi de la France,' tom. ii. p. 25 (1832).

‡ Kaup, 'Jahrbuch für Mineralogie,' 1835.

§ Ἱππίδιον (like ἱππάριον) signifies a small breed of Horse.

Fig. 4. Surface of horizontal section of the upper grinder, probably *p* 4, taken 1 inch below the unworn summit of that tooth: in this section the enamel-fold *g* forms an island.

Fig. 5. Worn grinding-surface of the upper grinder, probably *m* 2.

Fig. 6. Outer convex side of ditto.

Fig. 7. Anterior surface of ditto.

Fig. 8. Unworn summit of the last grinder, *m* 3.

Fig. 9. Worn grinding-surface of an upper grinder, probably *m* 1, of *Equus* (*Hippidion*) *neogæus*, Ld. (ex LUND (IV.)).

Fig. 10. Worn grinding-surface of an upper molar, probably *m* 2, of *Equus* (*Hippidion*) *principalis*, Ld. (ex LUND (IV.)).

Fig. 11. Worn grinding-surface of an upper molar of *Equus macrognathus*, Gv., $\frac{3}{5}$ nat. size (ex GERVAIS, *op. cit.*).

Fig. 12. Worn grinding-surface of an upper molar of *Equus* aff. *caballo*, Ld. (probably *Eq. curvidens*, Ow., ex LUND (IV.)).

Fig. 13. Worn grinding-surface of a lower molar, *m* 2, of *Macrauchenia patachonica*, Ow.

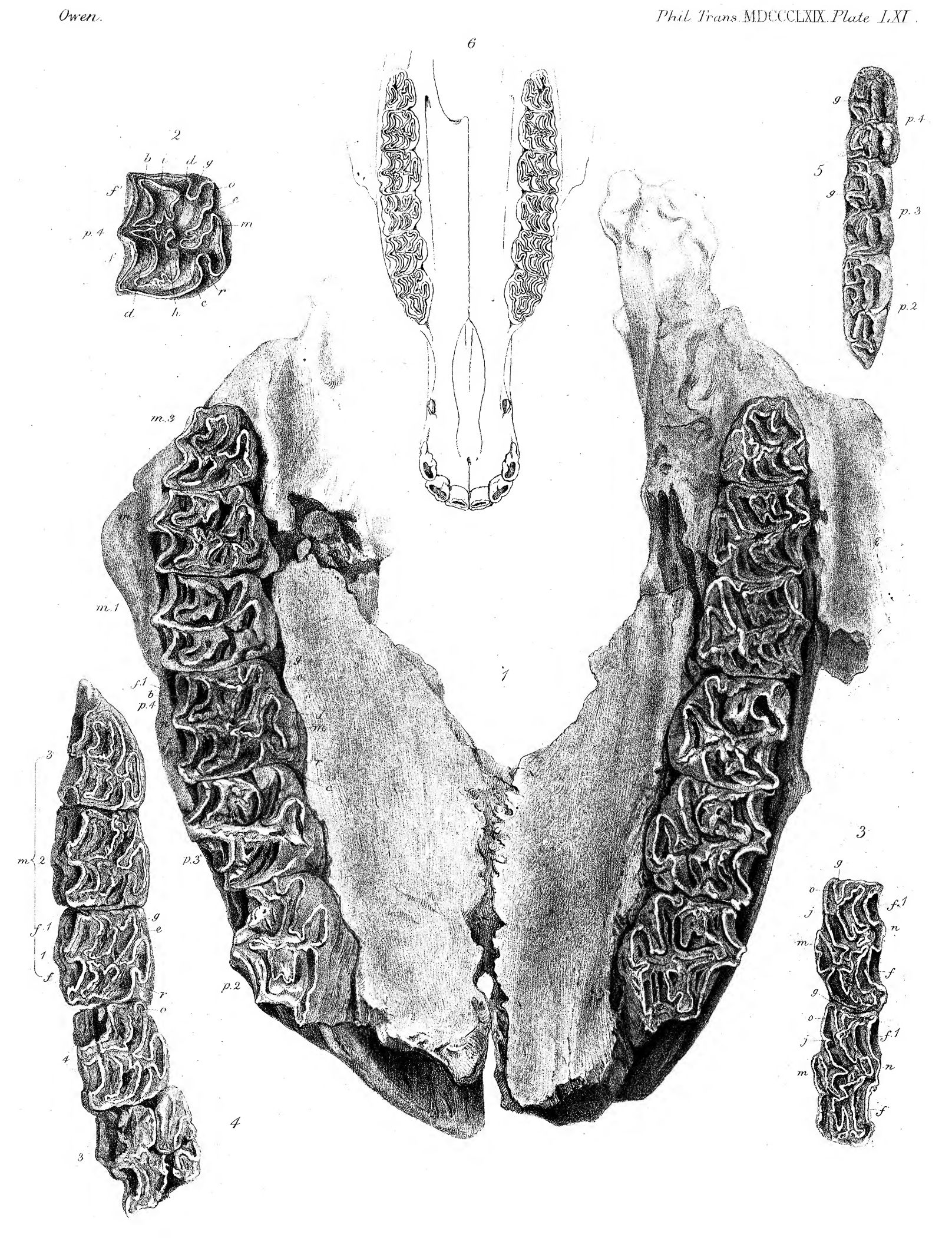
Fig. 14. Worn grinding-surface of a lower molar, probably *m* 2, of *Equus principalis*, Ld. (ex LUND (IV.)).

Fig. 15. Moderately worn grinding-surface of a lower molar of *Equus* aff. *caballo*, Ld. (probably *Eq. curvidens*, Ow., ex LUND (IV.)).

Fig. 16. Hinder surface of upper molar, *Equus curvidens*, Ow.

Fig. 17. Worn grinding-surface of a lower molar of *Equus Devillei*, Gv., $\frac{1}{2}$ nat. size (ex GERVAIS, *op. cit.*).

All the figures, save 11 and 17, are of the natural size.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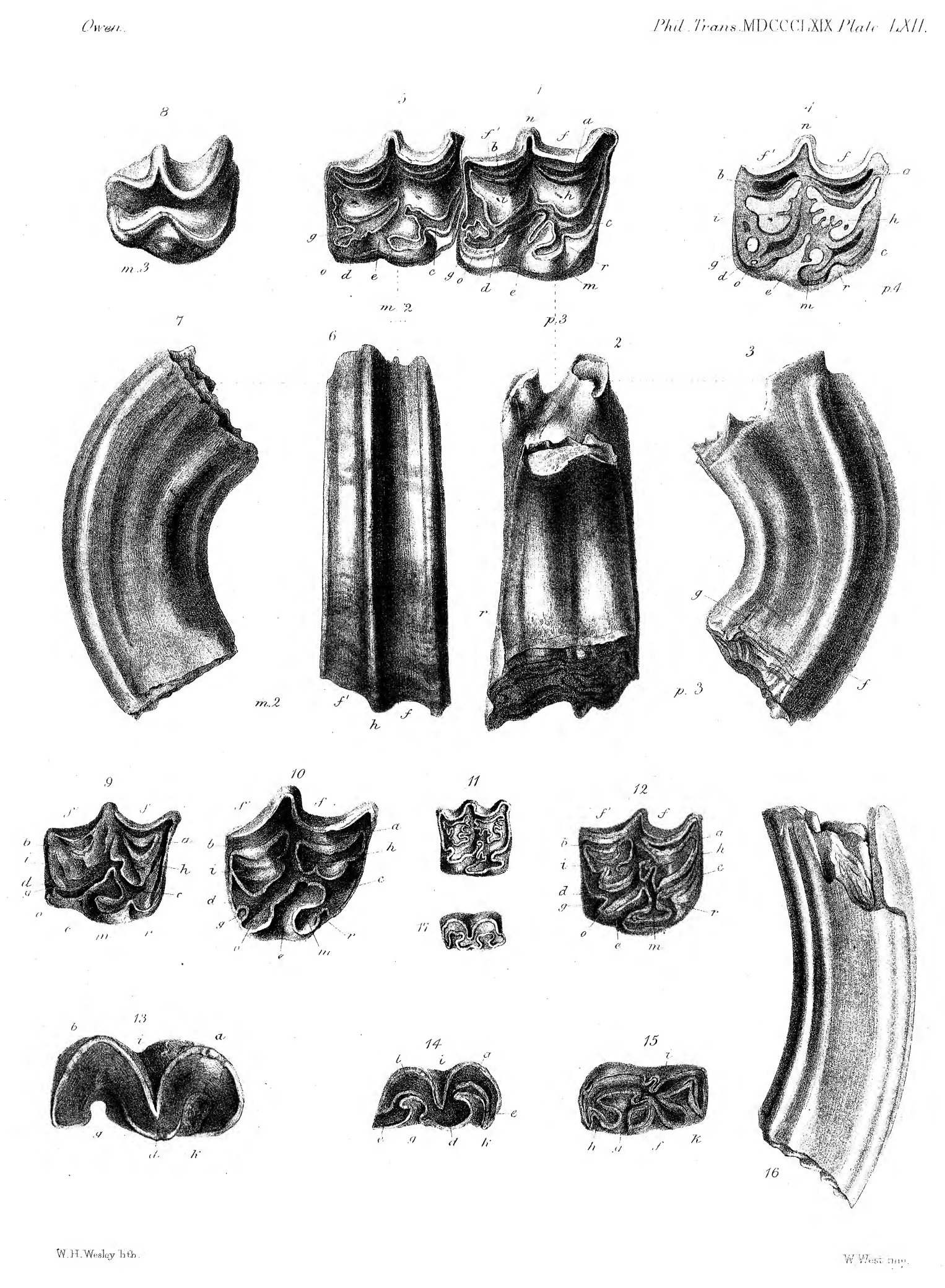
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